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THE WORK OF THE YUMA RECLAMATION PROJECT EXPERIMENT FARM IN 1916

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An irrigated pasture on the Yuma Reclamation Project

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THE PROGRESS OF AGRICULTURAL DEVELOPMENT.

The agriculture of the Yuma Reclamation Project is still passing through a formative period. This condition, existing also on other reclamation areas, is especially evident on the lands along the lower Colorado River because of the great variety of crops that can be grown in the warm climate. The natural advantage of a wide range of crops, combined with the adverse condition of high transportation charges and other somewhat depressing marketing conditions, has perhaps stimulated the tendency among farmers in this new country to change rapidly from one crop to another. The most important money-crop industries are now fairly well established, but the individual farmer has not generally concentrated on any definite selection of industries or any combination of crops to be grown in rotation that are at once the most valuable and the best adapted to his land and conditions. The money crops grown extensively on the Yuma project during the year 1916, in the order of their importance in total gross returns, were as follows: Cotton, alfalfa seed, alfalfa hay, and grain sorghum. The production of these cash crops and the establishment of certain live-stock industries now appear to be the basis upon which the agriculture of the region will ultimately become stabilized.

The object of this report is to discuss briefly the agricultural development of the Yuma Reclamation Project and to cover the more important features of progress of the work of the Yuma Experiment Farm during the year 1916.

THE YUMA EXPERIMENT FARM.

The tests and experiments conducted at the Yuma Experiment Farm [1] deal principally with crops and conditions of importance on the Yuma Reclamation Project. Much of this work, however, has a direct bearing on similar problems of near-by projects. The work on the experiment farm was begun in 1910. At present about 110 acres of land are being used for experimental purposes. During 1916 440 species, varieties, or strains of seeds and plants were received and tested, making a total of 1,739 during the past four years. The behavior of some of these plants has been discussed in former reports. Some are not yet sufficiently developed to warrant conclusions, while others are discussed in this paper.

Additional land, amounting to 5 acres, was brought into cultivation during the year 1916 by leveling rough land on the north side of series C and D, shown in figure 1. Concrete posts were made to replace willow posts on the east fence line. Three pastures were made by fencing alfalfa plats, which were utilized in alfalfa grazing tests with steers and hogs. Driveways through the experiment farm grounds were improved by the addition of concrete curbing.

The soil-improvement work, which is being continued wherever possible in order to eliminate the spottedness of fields, was advanced in 1916 by the production of green-manure crops on 10 acres of uneven soil. On 4 acres of this area four green-manure crops were produced and turned under during the one year. In each case the green material was mowed where the growth was heavy and dragged with a hayrake to lighter spots before being plowed under.

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

The weather conditions during the greater part of the year 1916 were very favorable to the growth of crops. Alfalfa hay was harvested during each month of the year except December. The total precipitation for the year was a trifle greater than normal, the heaviest rainfall occurring in January and December. Four months (May, June, October, and November) were without any rain. The records

[1] The Yuma Experiment Farm is located near Bard, Cal., on the Yuma Reclamation Project, 7 miles northeast of Yuma, Ariz. It consists of 160 acres of land, all of which is irrigable. The operation of this station is directed by the Office of Western Irrigation Agriculture of the Bureau of Plant Industry. Other offices of the Bureau of Plant Industry have cooperated in conducting experiments during the year as follows: The Office of Acclimatization and Adaptation of Crop Plants, in breeding and testing varieties of cotton and in growth studies of corn; the Office of Forage-Crop Investigations, in testing varieties of alfalfa, sorghums, and annual legumes; the Office of Cereal Investigations, in flax experiments; the Office of Crop Physiology and Breeding Investigations, in breeding and varietal tests with figs and dates; the Office of Foreign Seed and Plant Introduction, which has supplied various exotic species of fruits and ornamentals; the Office of Alkali and Drought Resistant Plant Investigations, in breeding and varietal work with pomegranates; and the Biophysical Laboratory, in making meteorological observations.

Various lines of investigational and advisory work with water users of the Yuma project have been acilitated by the hearty cooperation of local officials of the United States Reclamation Service.

show that for four consecutive years the months of May and June have been without precipitation. The first killing frost in autumn occurred on November 17, which was earlier than normal. However, on the night of November 13 a killing frost occurred here and there on the project, though large areas were unaffected. The minimum temperature recorded at the location of the thermometers on the experiment farm during this night was only 36° F. Severe

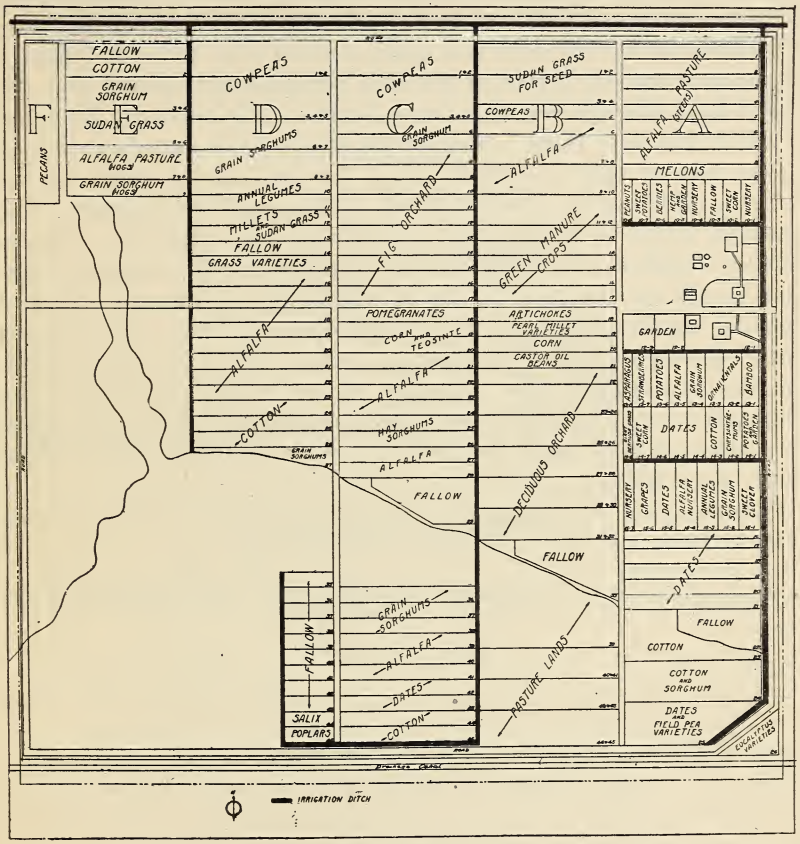

FIG. 1.—Diagram showing the arrangement of the fields and the location of the experiments at the Yuma Experiment Farm in 1916.

damage was done in the frosted areas to the most tender crops, such as sweet potatoes, peanuts, cowpeas, and cotton. The frost-free season for the year was 17 days shorter than the normal and in numerous cases reduced the yields of late-planted cotton and grain sorghum.

Evaporation for the year was a little less than the normal, which probably can be accounted for by the high humidity during July and early August. This condition occurring for a period of so many

consecutive days was unusual and with the high temperature experienced at that time made the month of July very unpleasant.

Field work during the midwinter season was interrupted by a damaging overflow of the Gila and Colorado Rivers on January 22, occasioned by excessive rains along the headwaters of the Gila River. Such a large volume of water was being carried by the Gila as to overtop and break the levees of the Colorado at the junction of these rivers near Yuma, Ariz., and below Yuma opposite the intake of the Imperial Valley irrigation system. About 18,000 acres of land was inundated for several days and again covered with water on January 30, when a second freshet of the Gila occurred and spread over the valley land through the same levee breaks. The recovery from the overflow was very rapid. Most of the alfalfa fields survived without severe loss of stand. Some of the heaviest alfalfa yields of the entire project were obtained from these overflowed lands. The principal losses to farmers were of poultry, hogs, and feed. Severe damage resulted to the main siphon canal and other smaller irrigation canals on the project, all of which the Reclamation Service repaired rapidly after the water subsided and before any serious water shortage occurred to crops in areas that were not flooded. On the experiment farm 35 acres of land were overflowed, the principal injury to crops being to tests of field peas and small grains. It is reported that this is the first occurrence of such a flood of these rivers since 1891.

Climatological observations recorded during the 7-year period from 1910 to 1916, inclusive, are summarized in Table I.

TABLE I.—*Summary of meteorological observations at the Yuma Experiment Farm, 1910 to 1916, inclusive.*

PRECIPITATION (INCHES).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Averages for 7 years, 1910 to 1916, inclusive	0.635	0.382	0.403	0.17	0.107	0.741	0.288	0.386	0.134	0.278	0.407	0.31	3.96
For 1916	1.66	.01	.30	.05	.....	.....	.46	.48	.32	.....	.....	.73	4.01

EVAPORATION (INCHES).

Averages for 7 years, 1910 to 1916, inclusive	3.087	3.958	6.423	6.880	9.710	10.360	10.023	9.493	7.595	5.808	3.892	2.834	80.063
For 1916	2.413	3.949	6.266	7.661	9.652	8.745	9.807	7.616	6.484	5.615	3.786	2.51	75.504

AVERAGE DAILY WIND VELOCITY (MILES PER HOUR).

1910	.....	.....	.....	.....	4.1	3.8	3.6	3.4	2.4	3.7	3.3	3.5	.....
1911	3.0	3.5	2.7	3.8	3.3	2.9	2.5	2.0	1.7	2.5	3.7	3.5	.....
1912	3.2	4.0	3.9	3.8	3.3	2.6	2.3	2.1	3.1	3.0	2.9	4.0	.....
1913	3.1	3.3	4.1	3.1	2.4	2.1	2.1	2.1	2.0	1.9	1.8	2.1	.....
1914	2.8	3.4	3.0	3.3	2.4	2.3	1.9	2.2	1.7	1.6	1.05	1.75	.....
1915	2.3	2.2	2.2	2.9	3.3	2.2	2.2	1.4	1.3	1.2	2.4	2.3	.....
1916	2.8	2.9	3.3	2.4	2.6	2.5	2.0	1.7	1.2	1.9	2.3	2.3	.....

TABLE I.—*Summary of meterological observations at the Yuma Experiment Farm, 1910 to 1916, inclusive*—Continued.

TEMPERATURE (° F.).[1]

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Absolute maximum:													
7 years, 1910 to 1916, inclusive.	84	88	99	106.5	120	117	116	113.5	116	107	94	81	120
For 1916.....	73	86	99	99	101	114	110	108	108	94	90	75	114
Absolute minimum:													
7 years, 1910 to 1916, inclusive.	16	27	30	32	33	47	55	54	46	36	28	16	16
For 1916.....	22.5	29	31.5	40	42	49	55	54	53	38	29	20	20
Mean:													
7 years, 1910 to 1916, inclusive.	52.69	55.99	62.20	67.89	74.44	81.0	87.42	87.8	81.78	69.71	60.22	50.47	69.30
For 1916.....	51.45	60.75	65.85	67.25	71.7	80.4	90	86.05	81.7	66.8	56.15	47.88	68.83

KILLING FROSTS.

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		° *F.*		° *F.*	*Days.*
1910.....	.....	.....	Nov. 27	32	.....
1911.....	Feb. 24	32	Nov. 24	32	262
1912.....	Mar. 31	32	Dec. 4	31	247
1913.....	Mar. 28	32	Dec. 2	31	248
1914.....	Mar. 4	31	Dec. 4	32	275
1915.....	Mar. 3	31	Nov. 13	31	254
1916.....	Mar. 25	31.5	Nov. 17	31	237

[1] The records of maximum and minimum temperatures date from Apr. 21, 1910.

IRRIGATION DEVELOPMENT.

The year 1916 was in many respects the most prosperous season in the history of the Yuma project. Extremely high prices and good yields are among the chief causes of this prosperity. Crops were produced on 28,283 acres, which was an increase of 3,182 acres over the cropped area of 1915. The total irrigated area amounted to 40.7 per cent of the total area of land that the Reclamation Service was prepared to supply with water. The gross return for crops produced on the entire Yuma project, calculated at local prices, amounted to $1,435,403, or an average gross return per acre of $50.75, which is an increase over 1915 of $15.94 per acre. This high return per acre was made possible by current high prices. In Table II is given a summary of the irrigation development of the Yuma project during the past five years, 1912 to 1916, inclusive.[1]

[1] The figures in Tables II, III, IV, and V have been taken from data collected by the local office of the United States Reclamation Service in annual census reports. The writer desires to express his appreciation for the use of these records, which embody information of general interest.

TABLE II.—*Summary of irrigation development of the Yuma Reclamation Project during the 5-year period, 1912 to 1916, inclusive.*

Item	1912	1913	1914	1915	1916
Water diverted.....acre-feet.	96,409	127,307	205,207	246,786	249,700
Water delivered to farms.....do...	63,273	85,411	93,167	92,897	94,393
Water delivered per acre irrigated....do...	7	4.36	3.69	3.34	3.20
Length of canals operated.....miles.	173	227.5	249.5	307.3	316
Land irrigable.....acres.	38.500	50,000	60,000	72,440	72,440
Land irrigated.....do...	13,767	19,607	25,207	27,857	29,483
Number of farms irrigated	470	616	698	737	790
Average population per farm	3.2	2.7	3.6	2.8	2.6
Total population on farms	1,490	1,793	1,815	2,036	2,002
Owners on farms	.....	496	468	659	453
Tenants on farms	.....	120	129	249	297
Areas cropped.....acres.	11,060	16,726	22,568	25,101	28,283
Financial showing:					
Total value of crops	$497,103.00	$610,228.00	$709,409.00	$873,721.00	$1,435,403.00
Value of crops per acre cropped	44.90	36.48	31.43	34.81	50.75
Value of crops per farm	1,057.50	993.00	1,016.00	1,185.51	1,816.97
Value of live stock per farm	952.00	1,250.00	1,201.00	1,071.67	1,018.84

Farm and community conditions have continued to improve over all parts of the project. The greatest development of general benefit has been the construction of 14 miles of paved road connecting the towns of Yuma and Somerton. This advantage, along with the operation of the Reclamation Service railroad from Yuma to the Arizona-Mexico boundary line, has greatly facilitated the transportation of crops. Many changes in land ownership have taken place, with a growing tendency toward larger individual holdings. There has been also an increase in land values and in land rentals.

CROP CONDITIONS.

The yields per acre of most staple crops about equaled those of previous years. Alfalfa hay made about the same average yield per acre in 1916 as in 1915, while the acreage was increased 15.2 per cent. Some hay was shipped out early in the season, but during later months the supply scarcely equaled the local demand. The price received was much better than during the last three years. The project produced more alfalfa seed during 1916 than during any previous year. Although the average price was lower than formerly the yields per acre were higher and the total return from this one crop was greater than ever before. Alfalfa seed was produced on a total area of 8,100 acres, with an average yield per acre of 352.2 pounds. Chilean (common) seed sold for an average of about 12½ cents a pound, while seed of the Peruvian variety sold for 22 to 30 cents a pound.

The largest money returns received from any one crop for the year were from cotton. In 1915 an average return of $61.59 per acre was obtained from an area of 709 acres, while 4,670 acres were grown in 1916, producing an average return of $100.15 per acre for lint and seed. This increase of acre return was due entirely to increased prices of cotton and cottonseed, as the average yield per acre was a

little less than for the previous season. Two cotton gins and one oil mill were in operation on the project in 1916.

The area producing small grains—that is, wheat and barley and also grain sorghum of the Dwarf milo and feterita varieties—was somewhat below normal, due largely to an increased cotton acreage. The yields of wheat and barley were lower than usual, while the grain-sorghum yields were very good. Near the close of the year these grains became scarce and the supply was not sufficient for local needs, even at the extremely high prices paid.

The yields and farm values of the crops grown on the project in 1916, as reported by the United States Reclamation Service, are shown in Table III.

TABLE III.—*Yields and farm values of crops grown on the Yuma Reclamation Project in 1916.*

Crop.	Area.	Unit of yield.	Yield.			Farm value.		
			Total.	Per acre.		Per unit of yield.	Total.	Per acre, average.
				Average.	Maximum.			
	Acres.							
Alfalfa hay	10,880	Ton	28,029	2.58	8	$9.52	$266,898	$24.53
Other hay	901	do	1,075	1.2	2	9.66	10,383	11.52
Alfalfa seed	8,100	Pound	2,635,800	325.2	780	.1247	328,725	40.58
Barley	1,195	Bushel	28,086	23.5	40	.69	19,433	16.26
Wheat	456	do	7,220	15.84	30	1.39	10,032	22.00
Grain sorghums	4,897	do	195,799	39.97	70	.64	124,915	25.50
Corn	55	do	1,875	34.00	40	.72	1,345	24.45
Cane and corn fodder	1,832	Ton	5,902	3.22	6	3.27	19,289	15.29
Cotton	4,670	Pound	2,289,430	490.00	1,000	.174	397,420	85.10
Cottonseed	4,670	Ton	2,291	.491	1	30.00	70,277	15.05
Beans	234	Bushel	2,328	10.37	12	4.00	10,215	43.65
Truck	338	Acre					25,038	74.08
Fruit	89	do					4,440	49.88
Pasture	7,282	do					82,643	11.35
Additional revenue [1]							64,350	
Less duplications	17,316							
Total	28,283						1,435,403	
Average								50.75

[1] From pasturing alfalfa, thrashed straw, and stalk lands in winter.

Something of the trend of development during recent years is indicated in Table IV, which shows the acreage, production, and farm values of each of the five principal money crops and of all crops for the years 1911 to 1916, inclusive.

TABLE IV.—*Acreage, production, and farm values of the principal crops grown on the Yuma Reclamation Project in the years 1911 to 1916, inclusive.*

Item and year.	All crops.	Alfalfa hay.	Alfalfa seed.	Grain sorghums.	Wheat and barley.	Cotton.[a]
Acreage:						
1911	8,570	3,750	[b] 2,600	420	1,290	30
1912	4,060	7,269	2,824	986	1,567	25
1913	16,726	10,321	3,388	2,928	1,586	62
1914	22,568	10,426	5,485	3,066	2,223	2,268
1915	25,101	9,441	6,449	6,408	3,838	709
1916	28,283	10,880	8,100	4,897	1,651	4,670
Production:		*Tons.*	*Pounds.*	*Bushels.*	*Bushels.*	*Pounds.*
1911		16,327	576,730	13,106	39,083	15,000
1912		27,078	814,186	31,372	55,375	5,800
1913		38,100	1,139,100	112,597	45,075	19,610
1914		32,525	1,246,318	100,153	61,674	845,044
1915		24,277	1,669,020	231,185	88,182	359,850
1916		28,029	2,635,800	195,799	35,306	2,289,430
Average yield per acre:						
1911		4.36	222	31.5	30.6	500
1912		3.73	288	31.8	35.3	232
1913		3.69	336	38.5	28.4	316
1914		3.12	227	32.6	27.8	373
1915		2.57	258.6	36.1	22.9	507.6
1916		2.58	325.2	39.97	21.39	490
Farm values per unit of yield:						
1911		$15.00	$0.16	$0.854	$0.66	$0.20
1912		10.00	.10	.75	.75	.20
1913		7.53	.111	.513	.668	.21
1914		6.05	.13	.70	.676	.08
1915		7.15	.1475	.63	.739	.109
1916		9.52	.1247	.64	.835	.174
Farm values per acre:						
1911	$51.80	65.44	32.52	23.62	20.20	100
1912	44.94	37.30	28.80	23.85	26.47	46.40
1913	36.48	27.83	37.33	19.72	18.95	66.50
1914	31.43	18.86	29.15	23.13	21.13	30.80
1915	34.81	18.36	38.66	22.61	16.97	61.59
1916	50.75	24.53	40.58	25.50	17.84	100.15
Total farm values:						
1911	443,984.00	244,905.00	92,276.00	11,180.00	25,775.00	3,000.00
1912	497,012.85	270,780.00	81,418.60	23,529.00	41,517.00	1,160.00
1913	610,228.00	287,195.00	126,450.00	57,740.00	30,131.00	4,123.00
1914	709,409.00	196,716.00	159,806.00	70,915.00	41,373.00	78,399.00
1915	873,721.00	173,297.00	249,331.00	144,892.00	65,135.00	39,271.00
1916	1,435,403.00	266,898.00	328,725.00	124,915.00	29,465.00	467,697.00

[a] Farm value per acre and total farm value of cotton include both fiber and seed.
[b] This area is included in the alfalfa-hay acreage for 1911.

LIVE-STOCK INDUSTRIES.

Table V shows an inventory of all live stock on hand on the Yuma project at the close of each year from 1911 to 1916. This is not a record of the project production, but it serves to show the comparative development of the various live-stock industries from year to year.

The principal development of the live-stock industry recorded in Table V is that of hog production, which shows an increase in numbers of nearly 10 per cent in 1916.

There was a decrease of 34 per cent in the beef-cattle population in 1916 as compared with 1915. This was due to the scarcity and high price of hay and grain. The cottonseed meal from the local oil mill was fed to some extent to both beef and dairy cattle, with good results reported. The dairy-cow population stands about the same as during 1915. There was sold to the Yuma creamery during 1916 a total of 123,239 pounds of butter fat, at an average price of 29.4 cents per pound. There is a tendency toward grouping the

dairy cows in larger herds, while dairymen who were operating on a small scale are going out of business.

TABLE V.—*Inventory of live stock on hand on the Yuma Reclamation Project at the close of each year, for the period from 1911 to 1916, inclusive.*

Live stock.	1911	1912	1913	1914	1915	1916
Number:						
Horses	1,570	1,705	2,111	2,465	2,898	2,950
Mules	362	440	560	544	612	756
Beef cattle [1]	967	1,197	3,900	2,851	3,446	2,251
Dairy cattle				2,043	2,249	2,234
Sheep				1,384	1,251	702
Hogs	1,767	2,634	2,886	4,982	12,500	13,688
Ostriches	40	121	184	193	121	91
Fowls	22,857	25,646	27,882	35,935	50,723	43,361
Bee colonies	2,433	2,542	2,712	4,062	2,480	4,569
Average value per head or unit:						
Horses	$106.00	$107.52	$105.00	99.48	$90.20	$100.75
Mules	128.00	127.33	150.00	138.37	126.86	117.02
Beef cattle [1]	51.40	49.52	58.00	37.68	44.66	43.04
Dairy cattle				81.42	73.02	41.40
Sheep				4.65	4.69	7.85
Hogs	7.15	9.07	8.65	7.60	6.49	7.90
Ostriches	315.00	186.95	145.00	5.57	5.83	17.69
Fowls	.64	.65	.62	.79	.65	.78
Bee colonies	3.15	3.21	4.00	4.80	4.84	3.40
Total value:						
Horses	166,389.00	183,364.00	221,525.00	245,227.00	261,410.00	295,245.00
Mules	46,340.00	56,030.00	84,329.00	75,272.00	77,640.00	88,470.00
Beef cattle [1]	49,705.00	59,270.00	224,251.00	107,434.00	153,906.00	96,873.00
Dairy cattle				166,335.00	164,235.00	159,505.00
Sheep				6,432.00	5,868.00	5,513.00
Hogs	12,627.00	23,903.00	24,965.00	37,848.00	81,122.00	108,183.00
Ostriches	12,600.00	22,625.00	26,610.00	1,075.00	705.00	1,610.00
Fowls	14,559.00	16,578.00	17,180.00	28,342.00	32,936.00	33,923.0
Bee colonies	7,674.00	8,159.00	10,832.00	19,499.00	12,002.00	15,565.00
Total	309,934.00	369,929.00	609,692.00	687,484.00	789,824.00	804,887.00

[1] Beef and dairy cattle for 1911, 1912, and 1913 were not segregated.

The swine population increased slightly during the year. As in the case of dairy stock, a tendency toward the development of some

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FIG. 2.—Hogs pasturing on Dwarf milo on the Yuma Reclamation Project in 1916.

large herds was noted. These herds were used rather extensively in hogging off crops of grain sorghum, as shown in figure 2.

The sheep industry on the Yuma project has never been very important, and the sheep population decreased during the past year.

A slight increase of work stock, both horses and mules, was noted, but it indicates only a normal growth for the increased acreage of the project. A few pure-bred draft stallions have been shipped in during the last year for use on the project. At the close of 1916 there was an average of 4.6 head of work stock for each farm, or an average of 7.63 acres per head of work stock on the entire area cropped. In addition to actual work stock, these figures include both young animals and breeding stock. The poultry industry continues to be important, but did not expand during 1916 as it did during 1915. Several new apiaries have been established, and several beekeepers already in the business have increased their holdings. A number of apiaries are located just off the irrigated land, but adjacent to large alfalfa fields on the project, where this range may be utilized.

DISEASES AND PESTS.

Animal diseases.—The production of all live stock and poultry was accompanied with comparative freedom from disease during the entire year. One outbreak of hog cholera occurred and a few cases of blackleg were reported, but both diseases were brought under immediate control. Disease among turkeys was less prevalent than for two years past.

Insect pests.—Thus far the many insect pests that are predacious on crop plants have not developed on the Yuma project to any serious extent. Among those of the most importance that sometimes appear are the spring grain aphis (*Toxoptera graminum*), the cotton or melon aphis (*Aphis gossypii*), the cotton stainer, or cotton-seed sucker (*Anasa* sp.), the alfalfa butterfly (*Eurymus eurytheme*), and the alfalfa-seed chalcis fly (*Bruchophagus funebris*). The first two insects mentioned did little damage to their host crops this season. The cotton stainer caused a greater loss of crops during 1916 than ever observed before in this locality. The injury produced by this insect is recognized by the hollow seed in the cotton boll surrounded by brown-stained fiber of inferior strength. In the ginned fiber these spots are noticeable as coarse, colored particles, and their presence reduces the value of the fiber accordingly. This injury occurs before the cotton seed is mature and while the boll covering is tender enough to be pierced by the insect, which feeds upon the liquid substance of the seed. This same insect commonly attacks the immature grains of sorghum, feeding on them in like manner. Damage inflicted by the alfalfa butterfly was serious only in localized areas. The fact that the average yield per acre of alfalfa seed on the project was above normal is explained, perhaps, by a generally low infestation by the chalcis fly. Several late seed crops were harvested that thrashed out good seed yields,

which is generally not the case during a season when the chalcis fly is abundant.

Plant diseases.—Very few plant diseases have yet become serious on the Yuma project. Those of the most importance now occurring are the smuts and rusts of grain crops and sore-shin and root-rot of cotton. Of the grain diseases barley smut was the only fungus that caused appreciable loss in 1916. Cotton root-rot has occurred only in small areas at a few places on the project. In several fields where this disease appeared it is reported that alfalfa was killed in a similar manner during previous seasons, but at that time the disease was not recognized as root-rot. The sore-shin of cotton is a fungous disease that affects cotton plants while in the seedling stage, giving the effect of stem decay just at the surface of the ground. It occurs most severely on rich soils, and especially in fields where cotton follows alfalfa. This fungus develops during periods of cold nights and warm days. The disease seems to disappear naturally as the nights become warmer, and if a sufficient quantity of seed has been planted it rarely damages the stand severely enough to necessitate replanting.

Bird and animal pests.—Damage to farm crops on the Yuma project by bird and animal pests, with two exceptions, has not yet become sufficiently extensive to be of much importance. The white-winged dove, which migrates to this section of the country from Mexico during July and August and feeds in grain fields, often remains and damages early crops of grain sorghum. It seems that the loss from this bird invasion can best be avoided by delaying the planting of grain sorghum until late June or early July, which will postpone maturity until most of the birds have gone. The pocket gopher has been a serious menace, owing to burrows made in ditch banks, which frequently result in the breaking of ditches, when the water finds its way through the bank in these burrows. These rodents have been effectively combated by the local representatives of the Reclamation Service by continual trapping.

Weed pests.—Weed pests that occur on the Yuma project were discussed in the report of this station for 1915. The conditions prevailing then have changed but little, except that the need of field inspection to control noxious weeds is becoming more necessary each season in order to continue to produce alfalfa seed that is free from such weeds as dodder, Johnson grass, and sour clover.

CROP EXPERIMENTS.

The results of the crop experiments at the Yuma Experiment Farm considered in this paper are mainly those relating to the principal money crops of the region, but some less important crops that occasionally have a valuable place as catch crops in a rotation

are also briefly treated. These experiments advanced very satisfactorily during 1916, and a more keen interest in this work was evidenced among local people than in previous years, as was shown by the many more farmers who visited the experiment farm to observe the crops being handled.

The principal experiments under way were (1) cultural and irrigation tests in cotton production; (2) the testing of cotton varieties; (3) the breeding of Durango, Tuxtla, and Kekchi cottons; (4) the testing of southern alfalfa varieties; (5) the disposal of alfalfa by pasturing hogs and steers; (6) the testing of summer forage crops; (7) the testing of flax varieties for seed production as a winter crop; (8) the testing of varieties of deciduous fruits; (9) the fruiting of seedling dates, figs, and pomegranates; (10) the testing of varieties of strawberries, blackberries, and dewberries; (11) the culture of truck crops; (12) the production of Bermuda onion seed; (13) the testing of various perennial ornamentals; and (14) the improvement of the soil by rotations of green-manure crops.

COTTON.

VARIETY TEST.

Experimental work with cotton during 1916 included the testing of 23 different varieties of both long and short staple cottons; breeding work with the Tuxtla, Kekchi, and Durango varieties; and cultural experiments with the Durango variety. Table VI presents the comparative yields of the varieties tested. The results of one season should not be taken conclusively regarding all or any of these varieties, but this test is a repetition of similar variety tests that have been made at the experiment farm during past seasons, all of which have contributed definite information as to the value and adaptability of varieties for this region.

TABLE VI.—*Yields of varieties of cotton grown on the Yuma Experiment Farm in 1916.*

Long-staple varieties.				Short-staple varieties.			
	Yield of seed cotton per acre (pounds).				Yield of seed cotton per acre (pounds).		
	Thinned twice.	Thinned once.	Average.		Thinned twice.	Thinned once.	Average.
Durango [1]	1,761	1,761	1,761	Acala [1]	2,700	2,539	2,620
Lewis	1,315	1,464	1,390	Dixie	2,431	2,160	2,296
Columbia	1,560	1,020	1,290	Cleveland	2,375	1,783	2,079
Express	1,093	1,432	1,263	Half-and-Half	2,160	1,783	1,972
Foster	1,103	1,114	1,109	King [1]	1,836	1,781	1,809
Snowflake	847	1,167	1,007	Holdon	2,000	1,567	1,784
Meade	1,103	858	981	Tuxtla	1,892	1,620	1,756
Kekchi	880	954	917	No. 624	1,727	1,783	1,755
Egyptian	679	636	658	Ideal	1,620	1,781	1,701
Keenan	403	551	477	Trice	1,675	1,511	1,593
Sea Island	212	106	159	Triumph (*Mebane*)	1,675	1,351	1,513
				Lone Star	1,405	1,027	1,216

[1] The Acala, Durango, and King varieties may have been favored by their locations on the borders of the test plats.

The varieties the tests of which are recorded in Table VI were planted on April 18, which was a desirable date for planting all Upland cottons but entirely too late in the season for such varieties as Egyptian and Sea Island cotton; therefore, little significance should be attached to the yields of these two varieties in these tests, as the comparison is not indicative of the value of the varieties that require a longer season. When all conditions of culture and behavior for the past season are considered, several varieties other than those already being grown commercially stand out as worthy of further trial in field plantings in comparison with recognized valuable varieties. The Egyptian, Durango, Tuxtla, and Acala varieties will be grown at the experiment farm in such a test during 1917.

THE FURROW-AND-BED METHOD.

It is generally recognized among farmers who are growing cotton under irrigation that certain losses occur annually through faulty methods of irrigation. This problem has been given particular attention during the past two years, which has led to the trial of a method of planting cotton on lister beds, the rows being situated just above the water line on both sides of a broad furrow.[1] These beds are high enough not to be flooded by irrigation water, while the water easily reaches the roots of the plant. In order to make such a planting practicable, a planter different from those ordinarily in use is necessary. Such a planter as has been devised is shown in figure 3. With this implement the preparing of cotton land and planting by this method are not as expensive or difficult as might at first be supposed.

After the field is prepared in the usual way, furrows are laid off with an ordinary 14-inch lister at the desired distance apart. This is followed with a light irrigation, which consists of filling the furrow with water. This irrigation fills both the needs of locating any high spots and leaving the soil of the furrow banks moist for the seed. If there are any high furrows or parts of furrows, they may be rapidly gone through again and opened out to the proper level. The field is then ready for the planter, which consists of a planting attachment mounted on a sulky lister. The implement carries a 16-inch lister bottom, as it has been found desirable that this bottom be larger than the one used in laying off the original furrows, in order that a well-formed furrow may be made, which will not easily be filled by earth falling back. The draft of such an implement is not heavy, and it can be drawn by two good horses. A planter as described will place the pair of rows about 24 to 26 inches apart across the furrow. A test

[1] The need of a method of planting cotton such as is here described was first recognized by Mr. O. F. Cook, of the Bureau of Plant Industry, at whose suggestion this work was undertaken to make more effective under local conditions the single-stalk method of cotton culture.

to ascertain the best width of bed to be left between furrows indicates that 5 or 5½ feet is the most desirable of the widths tested. The yields in this test are recorded in Table VII.

TABLE VII.—*Yields of Durango cotton grown by the furrow-and-bed method at various bed widths on the Yuma Experiment Farm in 1916.*

Distance between furrows, center to center.	Distance between rows (inches).		Yield of seed cotton per acre.	
	Across bed.	Across furrow.	Pounds.	Bales.
6 feet	48	24	1,610	1.022
7 feet	60	24	1,760	1.116
7.5 feet	66	24	1,840	1.167
8.5 feet	78	24	1,450	.92

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FIG. 3—A sulky lister provided with a double-row attachment for planting cotton by the furrow-and-bed method on the Yuma Experiment Farm in 1916.

Although this method is not yet to be recommended for general planting until tested further and on a larger scale, it is evident that it tends to correct several difficulties in the methods of planting and irrigation now in vogue. The principal advantages of this new method are the following: (1) The possibility of irrigating to force germination without crusting the soil over the seed, thus assuring a stand on hard soils; (2) avoiding the excessive early irrigation, which tends to produce a large and undesirable vegetative plant growth early in the

season; (3) pickers may, if necessary, return to work in the field very soon after an irrigation by following the high beds; (4) during the late season when the plant lodges with a heavy crop, it falls on dry beds, thus avoiding the loss from decayed and damaged bolls that results when all the ground surface is wet from irrigation water; (5) a more economical use of irrigation water. This method provides for each row the desirable conditions of ample light and air exposure, which doubtless are the chief factors contributing to the development of the superior plants that are always found in outside rows or at the end of rows of plantings made in the ordinary manner.

A system of cultivation for such a method of planting must be different from that now practiced. A narrow 1-horse cultivator and a

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FIG. 4.—A field of Durango cotton planted by the furrow-and-bed method on the Yuma Experiment Farm in 1916. The dry beds are visible between the pairs of rows.

large single sweep may be used in furrows to control weed growth, while on the beds very little cultivation will be necessary to keep down the weeds. As the furrows become completely shaded, weed growth is reduced to a minimum. Foul or poorly leveled land will be much more difficult to handle by this method than fields in good condition. On some soils it has been found that an ample supply of water can not be secured in midseason by irrigating only through the furrows. In such cases the entire field may be flooded once or twice, as in the case of ordinary flat plantings, and the furrow irrigation again resorted to later in the season, when the water requirement is lower and when picking is going on. A field of Durango cotton planted by this method is shown in figure 4.

ALFALFA.

VARIETY TESTS.

Most of the experiments with alfalfa conducted during the season of 1915 were repeated in 1916, with verifying results. The yields produced by the different plats of alfalfa in the field variety tests are recorded in Table VIII, in comparison with the yields of 1915. Stands on these plats were two years old this season, while the yields of 1915 were from a first year's growth.

TABLE VIII.— *Yields of varieties of alfalfa grown in field plats on the Yuma Experiment Farm in 1915 and 1916.*

Variety.	Yield per acre (tons).		Variety.	Yield per acre (tons).	
	1915	1916		1915	1916
Peruvian	2.42	4.8	Arabian	1.96	2.5
Chilean (common)	2.42	4.0	Grimm	1.32	3.0

It will be noted from Table VIII that Peruvian alfalfa (which is locally known as hairy-leaved Peruvian) has yielded more heavily during both years than any of the other varieties.

The alfalfa nursery of 46 foreign varieties that was started in 1915 was carried through 1916 for further study. The most promising variety of this group is a strain from India, which in this climate grows well and yields heavily. In behavior it is much like the Peruvian alfalfa, which is already being grown extensively. Field row plantings of the Indian alfalfa have been made and seed harvested, in order to make field plantings to determine its hay yields as compared with the best varieties now being grown.

ALFALFA SEED.

The production of alfalfa seed on the Yuma project has developed to such proportions that growers and seed dealers should consider carefully the needs of the various markets where this seed can be sold and should handle it accordingly. Three varieties or types are grown for hay on the project, and seed is produced from all these types. These varieties show greater differences in some other sections than in this region; consequently, the seed of each variety should be kept pure if it is to be sold in outside markets.

Prior to 1900 the most popular variety of alfalfa in the Southwest was the one known as Chilean. This variety was brought into California about the middle of the last century. Not only does it thrive in the Southwest, but seed produced there has given good results when planted in the Northern and Eastern States, and a good market for Yuma seed has been developed in these sections.

Peruvian alfalfa was introduced into the United States from Peru in 1899 by the United States Department of Agriculture and by thorough tests was found to be well adapted to the irrigated regions of the Southwest. The scarcity of seed that existed when farmers learned of this variety induced the department to attempt to secure more Peruvian seed. A second importation was made from Peru, but owing to the lack of information regarding varieties in that country a somewhat different strain was secured, which proved to be inferior to the variety first imported, though better than the varieties in general use. Both Peruvian varieties became established on the Yuma project, the first importation being known locally as hairy-leaved Peruvian and the second as smooth-leaved Peruvian.

Peruvian alfalfa has succeeded extremely well in the Southern and Southwestern States, but is not recommended for the Northern and Eastern States where low winter temperatures occur. From these facts it can be readily seen that the indiscriminate growing or selling of alfalfa seed could very soon ruin the market possibilities for Yuma-grown seed. Seed of the Peruvian varieties should not be shipped to distributors in eastern or northern regions. For the future success of the Peruvian seed industry it is advisable that as rapidly as possible growers eradicate the smooth-leaved type and grow only the hairy-leaved type.

While Peruvian alfalfa has been found distinctly the best variety for hay production on the Yuma project, the fact remains that the production of alfalfa seed is at present the second most important crop industry of the project, and a part of the market for this seed is in the Eastern States. For this reason some attention should be given to the production of Chilean (common) alfalfa seed if this market is to be retained. However, during the past year there was not a sufficient quantity of hairy-leaved Peruvian seed to supply the demands of the Southwest, and the prices were very high. The area planted to this variety is increasing, as it should for a time at least, as a large portion of the territory supplied with Yuma alfalfa seed at present is in the Southwest.

PASTURING ALFALFA WITH HOGS.

The production of hogs on the Yuma project is based almost entirely on the use of alfalfa pasture, either with or without a supplementary grain ration. In order to determine the relative value of the alfalfa crop as hay or as hog pasture, a test was begun on the experiment farm early in the year. Six pigs of an average weight of 59 pounds were placed on one-fourth of an acre of Peruvian alfalfa on February 9. The pasture was divided into two lots, allowing the

pigs to be changed from one side to the other each week, irrigating each pasture every two weeks. These pigs were weighed individually each week and the weights recorded for calculating the grain ration for the following week. A supplementary grain ration of cracked Dwarf milo was fed at the rate of 2 pounds a day for each 100 pounds of live weight. On April 5, after a pasture period of 56 days, the hogs were turned into a half-acre field of Canada field peas, estimated to yield 150 pounds of peas, or at the rate of 300 pounds per acre. At this time the hogs averaged 99.3 pounds each. The herd was held on the field peas and alfalfa for 14 days, during which time an average gain of 13.7 pounds per animal was made. All the field peas had been cleaned up at the close of this period, and for a final finishing period of 10 days a grain ration of about 4½ per cent was fed in addition to the alfalfa pasture. These hogs were marketed on April 29, after a total pasturing period of 80 days, at an average weight of 121 pounds. On June 20 a second lot of pigs of an average weight of 71 pounds were placed on the same pasture and fed a supplementary grain ration of 2 per cent cracked Dwarf milo for 126 days, at the end of which time they averaged 170 pounds in weight. The hogs were then turned on a one-half acre field of Dwarf milo, still being allowed access to the alfalfa pasture but being fed no other grain. It was estimated that the field of Dwarf milo yielded 937 pounds of grain, or at the rate of 1,874 pounds per acre. The hogs had cleaned up all the grain in the field after 21 days and were marketed November 14 at the close of an entire pasturing period of 147 days with an average weight of 191.6 pounds. Condiments consisting of slaked coal, rock salt, and rock phosphate were kept before the hogs continually. A total of 69 pounds of this mixture was consumed during the season.

From the middle of July until the close of the pasturing test it seemed that the alfalfa was being pastured a little too heavily. On October 24, at the time the hogs were turned on the Dwarf milo, the alfalfa was carrying at the rate of 4,080 pounds of live weight per acre. Alfalfa stands that are pastured as heavily as this are generally damaged by close grazing and by the increased opportunity for infestation by Bermuda grass.

Table IX shows the gains by and returns from these two lots of hogs when values are accepted as follows: Pork gain worth 7 cents a pound; grain worth 1 cent a pound; equivalent hay production of 5 tons per acre at $8 a ton, or $40 a year, which would make alfalfa pasture worth 17.6 cents a day per acre if figured on the meadow basis and pastured for 227 days.

TABLE IX.—*Results obtained by grazing two lots of hogs on alfalfa pasture supplemented with a 2 per cent grain ration at the Yuma Experiment Farm in 1916.*

Items of comparison.	First lot.	Second lot.	Entire season.
Number of hogs per acre	24	24	24
Total gain per acre ..... pounds..	1,818	2,995	4,813
Length of pasturing season ..... days..	80	147	227
Average daily gain per acre ..... pounds..	22.7	20.38	21.20
Total grain fed per acre (including peas and milo) ..... do....	3,607	10,419	14,026
Grain fed per pound of gain ..... do....	1.983	3.48	2.91
Gain per 100 pounds of grain ..... do....	50.4	28.8	34.3
Financial statement:			
Net return per acre of pasture	$91.19	$105.46	$196.65
Daily returns per acre of pasture	1.14	.717	.867
Cost per 100 pounds of gain (pasture rent at $40 per acre per year, or 227 days at 17.6 cents per day; grain at 1 cent a pound)	2.76	4.39	3.75
Equivalent paid by hogs for hay per ton	45.60	35.15	39.23

The term "net return" as used in Table IX refers to the difference between the total value of the gains in weight, at 7 cents a pound, and the value of grain consumed, at 1 cent a pound, without deducting production cost, interest on investment, or risk. Figuring on the same basis of alfalfa pasture worth 17.6 cents an acre per day the Canada field peas gave a net return per acre of $10.25, or 3.42 cents per pound. Also the Dwarf milo hogged down gave a net return per acre of $19.71, or 1.05 cents per pound of gain.

PASTURING ALFALFA WITH CATTLE.

A grazing test of steers on a mixture of alfalfa and Sudan grass was conducted. On June 6 eight head of Hereford steers were placed on 4 acres of winter-seeded Peruvian alfalfa, with Sudan grass seeded in the alfalfa on April 20. The pasture was on very sandy soil which had been cropped for five years and was used in this experiment to ascertain the carrying capacity of alfalfa pasture on such soil and the amount of beef gains produced per acre and also to determine the improvement of soil handled in this manner. The herd consisted of seven long yearlings and one 2-year-old, all range stock and averaging 610 pounds in weight when placed on the pasture. A view of the pasture is shown in figure 5. The pasture was fenced in two divisions, and the stock was first turned in when the alfalfa was in full flower. As nearly as possible this practice was continued throughout the season, but could not be maintained in a satisfactory manner through the warmest weather, owing to the fact that the pasture required irrigation at 14-day intervals, at which time the stock was moved to the other division, which interval of time was not sufficient to permit the development of a mature crop. It is generally believed among stockmen that the greatest gains will be made by cattle on alfalfa pasture when the mature crop rather than the younger and more succulent growth is pastured. The

Sudan grass did not become very well established, but produced the greatest amount of feed during August and September, when the alfalfa was growing least. During July and August the pasturing of two head of steers per acre was a little more than this soil could carry to advantage. The gains made during July were very slight, which, however, was no doubt partly due to the excessively hot weather. On October 6, after a total pasturing period of 122 days, a total gain of 1,641 pounds had been made, or 410 pounds an acre, which, with beef gains figured at 6½ cents a pound, gave a net return per acre of $26.25. The same herd was kept on this pasture until November 6, but during the last 30 days no gains were made. If the alfalfa had been an old stand, pasturing could have begun much earlier in the season.

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FIG. 5.—Steers being pastured on Peruvian alfalfa and Sudan grass on the Yuma Experiment Farm in 1916.

GRAIN SORGHUMS.

VARIETY TEST.

The variety testing of grain sorghums in 1916 was continued with a few of the most promising sorts from among the series tested in 1915. Two notably prominent varieties stand out with good grain yields above all other newly tested varieties, namely, Dwarf hegari, with a yield of 43 bushels per acre, and Shrock kafir, which yielded 31 bushels per acre. However, as these are only the results of one season in a field test the varieties should not be recommended for general planting until tested further.

SPACING TEST.

Farmers growing sorghums often inquire as to what is the optimum distance to space plants in the row. Many different ideas seem to be held in this regard, but generally without actual figures to substantiate them. The results of plantings of the Dwarf milo variety for three years are recorded in Table X, which seems to answer this inquiry quite consistently for the medium type of soil that is found over the Yuma project.

TABLE X.—*Results secured in a spacing test of grain sorghums at the Yuma Experiment Farm during the years 1913, 1915, and 1916.*

Space between plants in the row.	Variety.	Number per plant.		Average number of medium-filled heads per stalk.	Character of heads.		Yield of thrashed grain.	
		Average stalks.	Total heads.		Chaffy.	Filled.	Per acre.	Relation to air-dry heads.
Season of 1913:					*Per cent.*	*Per cent.*	*Bushels.*	*Per cent.*
4 to 6 inches	Dwarf milo						26.7	
12 to 14 inches	do						20.3	
18 to 21 inches	do						20.7	
24 inches	do						22.7	
Season of 1915:								
4 to 6 inches	do	1.8	4.4	1.5	38.7	61.3	19.1	64.7
12 to 14 inches	do	3.9	9.6	1.6	37.5	62.5	19.5	61.7
18 to 21 inches	do	3.5	7.9	1.2	40.5	59.5	17.2	60.0
24 inches	do	3.7	7.9	1.3	39.2	60.8	14.3	67.2
Average for 1913 and 1915:								
4 to 6 inches	do						22.9	
12 to 14 inches							19.9	
18 to 21 inches	do						18.9	
24 inches	do						18.5	
Season of 1916:								
12 to 14 inches	do	2.5	2.65	.94	11.7	88.3	37.2	75.6
18 to 21 inches	do	2.23	2.61	.86	26.5	73.5	25.3	72.1
12 to 14 inches	Feterita	2.87	4.14	1.12	22.7	77.3	24.0	72.8
18 to 21 inches	do	2.1	3.39	1.16	28.0	72.0	20.2	70.1

It will be noted from Table X that the average results for two years indicate that the closest spacing of plants in the row produces more thrashed grain than any other distance tested. In 1915 the percentage of thrashed grain from air-dry head grain was highest from the widest spacing and only slightly lower for the closest spacing. The percentage of well-filled heads as compared with chaffy heads was not significantly different in any case. The size of heads is invariably larger when the stand is lighter, which, if the grain yield were the same, would be quite a factor in the cost of harvesting. The variation in the number of stalks and heads per plant in 1915 and 1916 is probably due to a difference of seasons, but also may be due in part to different planting dates, as the 1915 planting was made on May 22, while the 1916 planting was made on June 28.

During 1914 a similiar spacing test was conducted at this station with Dwarf milo, but this was on heavier silt soil and is not comparable with the results of the years included in this report. On the most productive soils of the project it is likely that the highest yields of grain sorghums will be obtained from plantings slightly more than 14 inches apart.

In the 1916 tests feterita yielded less than Dwarf milo and gave 2½ per cent less of thrashed grain from air-dry head weights than Dwarf milo.

OIL CROPS.

The production of cotton in the Southwest has carried with it the development of a cottonseed-oil industry of considerable importance, and several oil mills are now established in this region. With such

equipment already established, there comes the suggestion of other oil crops that might be handled, and this has led to the testing of flax, castor beans, peanuts, and soy beans at the experiment farm.

FLAX.

The use of flax as a winter crop under irrigation in this climate is new, and no information is available except that obtained during the years 1914, 1915, and 1916 by experiment stations in this region. Plantings at the Yuma Experiment Farm have thus far been made on small areas, principally as variety tests in nursery rows. During 1916 twenty varieties were carried in a nursery-row test. Six varieties were grown in broadcasted plats and a date-of-seeding test was conducted with variety C. I. No. 13.[1]

The broadcasted plantings were made on November 13, 1915, on a medium-heavy silt soil that was in good condition for planting, and very good stands were obtained. However, as the season advanced, these plantings made very poor growth, and it seemed that the soil was probably encrusted too solidly about the stems, which condition was intensified by each irrigation. Possibly there were other conditions that retarded the development of these plantings, but none could be determined. The same varieties were planted on similar soil in rows 18 inches apart on November 7 and were cultivated with a 1-horse cultivator after each irrigation. These row plantings made a very good growth and produced good yields. A comparison of yields is shown in Table XI.

TABLE XI.—*Yields of six varieties of flax seeded broadcast and in rows at the Yuma Experiment Farm in 1916.*

C. I. variety.	Date of seeding.		First flower.	Mature.	Yield per acre (bushels).	
	Broadcast.	In rows.			Broadcast seeding.	Row planting.
No. 30	Nov. 13, 1915	Nov. 7, 1915	Mar. 5, 1916	May 25, 1916	4.8	17.0
No. 3	do	do	do	May 15, 1916	4.5	23.8
No. 20 [a]	do	do	Feb. 20, 1916	May 25, 1916	3.4	.....
No. 13	do	do	Mar. 1, 1916	do	2.5	13.5
No. 36 [a]	do	do	Feb. 26, 1916	May 6, 1916	1.8	.....
No. 21	do	do	Feb. 15, 1916	Apr. 30, 1916	.6	21.3

[a] Not included in row plantings.

Of 20 varieties grown in this varietal test, 6 yielded at the rate of more than 20 bushels per acre. The date-of-seeding test consisted of row plantings made at intervals of about 15 days from November 8 to February 18. The highest seed yield was produced from the planting made on January 3. Other plantings have been made to carry this work farther during the coming year.

[1] All flax varieties have been carried under a series of numbers assigned by the Office of Cereal Investigations, the work being conducted in cooperation with that office.

CASTOR BEANS.

A half-acre plat of castor beans was planted in rows 44 inches apart on March 25. The soil was rather uneven, one end of the plat being very sandy. On half of the block the plants were thinned to a distance of about 24 inches in the row, while on the other half the plants were left about 12 inches apart. The beans began to mature early in the summer and were harvested at frequent intervals. Harvesting consisted of going through the field and cutting the seed clusters when most of the seed pods began to turn brown. The seed can not be left long on the plant, for the reason that as soon as a pod becomes dry it cracks open with a force that sometimes sends the seed several feet away. Of the total crop, it was estimated that at least one-third of the seed was lost by shattering, while some other seed was lost by being cut before it was sufficiently mature. After the seed clusters are cut it is necessary that they be spread out to dry before being thrashed. The plat which was thinned to 12 inches in the row yielded at the rate of 574 pounds per acre, while the plat thinned to 24 inches gave a yield of only 373 pounds per acre. Tests to ascertain the oil content and quality of these beans have not yet been made.

PEANUTS.

Much of the soil of the Yuma project is well adapted to the culture of peanuts if a market should be found for this crop. From plats of very sandy soil planted in 1916 a yield of dry peanuts of 1,395 pounds per acre was obtained. On better soil the yield would no doubt be heavier. Peanuts succeed best on a sandy loam soil and require frequent irrigations. Seed planted on April 29 matured in 205 days.

SOY BEANS.

A variety test of soy beans grown for both forage and seed yields is discussed in this report under "Miscellaneous forage crops." A record of the seed yields of several varieties is presented in Table XV. All seed yields from soy beans grown on this project have been relatively small.

MISCELLANEOUS FORAGE CROPS.

In cooperation with the Office of Forage-Crop Investigations, a number of forage and green-manure crops were tested during 1916. While some of these crops are not specially important in this region, they have been tested in order to secure information to meet the frequent inquiries received regarding them.

GRASSES FOR IRRIGATED PASTURES.

Six pasture grasses and one clover were planted during November, 1915, to be compared with Sudan grass as an irrigated pasture crop. The varieties included were meadow fescue, awnless brome-grass (*Bromus inermis*), tall oat-grass, timothy, perennial rye, and alsike clover, of which all made slow growth and none produced sufficient pasture to compare favorably with Sudan grass. The uses of Sudan grass for hay and pasture were discussed in the reports of this station for the years 1914 and 1915. The grass has given good results and is finding a place among the crops of the region. A Sudan grass pasture at the Yuma Experiment Farm is shown on the title-page.

MILLETS.

Several varieties of millets were again tested both for forage and seed production. The yields of these varieties are recorded in Table XII.

TABLE XII.—*Forage and seed yields of varieties of millet grown on the Yuma Experiment Farm during 1915 and 1916.*

Variety.	Yield per acre.				Variety.	Yield per acre.			
	Forage (tons).		Seed (pounds).			Forage (tons).		Seed (pounds).	
	1915	1916	1915	1916		1915	1916	1915	1916
German	1.57	1.53	539	.....	Japanese	2.71	.....	341	.....
Turkestan	2.46	1.76	625	.....	Ragi	.....	2.21	795	451
Goldmine	3.26	.73	710	.....	Pearl	.....	6.2	2,890	.....
Foxtail (S. P. I. No. 35339)	.....	3.34	1,307	428					

Because of the leafy growth and high forage yield of Pearl millet, it would appear to be valuable as a soiling crop for dairy cattle. Ragi millet produced a very good quality of forage, which was eaten readily by horses. The other varieties included in this test are better known and the results have already been reported.

FORAGE SORGHUMS.

Twelve varieties of forage sorghum found to be the best suited to this region were grown in a variety test under comparable conditions and on similar soil. The forage and seed yields produced and the relative rank of varieties are shown in Table XIII.

TABLE XIII.—*Forage and seed yields of twelve varieties of forage sorghum grown on the Yuma Experiment Farm in 1916.*

Variety.	Forage crop.				Seed crop.			Length of season to mature seed.
	Stand.	Yield per acre (tons).		Rank.	Stand.	Yield per acre.	Rank.	
		Green.	Air dry.					
	Per ct.				*Per ct.*	*Pounds.*		*Days.*
Gooseneck	70	17.8	8.5	3	85	1,355	8	144
Honey	95	22.2	9.9	2	95	1,528	2	149
Texas Seeded Ribbon	98	22.1	10.9	1	98	1,422	6	117
Kansas Straightneck	75	13.5	5.6	8	75	1,443	5	123
White African	85	15.2	7.9	4	90	1,450	4	117
Orange	90	10.2	7.3	5	90	1,963	1	118
Sumac	75	14.9	7.0	6	90	1,400	7	130
S. P. I. No. 23420	40	5.8	3.1	12	40	930	10	113
Black Amber	90	13.9	5.8	7	90	800	11	97
Planter	90	10.2	4.6	9	90	1,505	3	117
Early Amber	80	9.1	4.0	10	80	437	12	98
Dakota Amber	95	8.5	3.4	11	95	1,022	9	82

COWPEAS.

A variety test of cowpeas was conducted during 1916, including several varieties not previously tested, compared with two other standard varieties, the Groit and Whippoorwill. The relative yields of these varieties are shown in Table XIV.

TABLE XIV.—*Forage and seed yields of seven varieties of cowpeas grown on the Yuma Experiment Farm in 1916.*

Variety.	Yields per acre.			Variety.	Yields per acre.		
	Forage (tons).		Seed.		Forage (tons).		Seed.
	Green.	Air dry.			Green.	Air dry.	
			Pounds.				*Pounds.*
Monetta	13.89	2.44	386	Early Buff	3.44	0.77	144
Early Red	6.7	1.56	442	Whippoorwill	3.8	.64	.....
Groit	5.91	1.23	.....	Brabham	3.64	.56	.....
Blue Whippoorwill	4.8	.81	.....				

Of these varieties, the Monetta cowpea gave an especially good forage yield.

Cowpeas were also grown on newly leveled sandy land as a green-manure crop. On the spots with the heaviest soil, good yields of seed were made by the Groit and Brabham varieties, while on the sandy portion scarcely any seed pods were set.

SOY BEANS.

Seven varieties of soy beans were grown on rather sandy land of a type where the production of a leguminous crop as a green manure is important for building up the soil. Of these tested, the Mammoth variety (fig. 6) produced the largest yield of green manure, while the

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FIG. 6.—A plat of Mammoth soy beans on the Yuma Experiment Farm in 1916.

Black Eyebrow soy beans matured the largest yield of seed. Table XV shows the yields of forage and seed for these varieties.

TABLE XV.—*Forage and seed yields of seven varieties of soy beans grown on the Yuma Experiment Farm in 1916.*

Variety.	Yields per acre.				
	Forage crop weight (tons).			Seed crop.	
	Green.	Air dry.	Rank.	Weight (pounds).	Rank.
Mammoth	3.5	1.07	1	219	3
S. P. I. No. 25135	3.34	.93	2	110	6
Barchet	2.4	.81	3	192	4
Black Eyebrow	2.26	.71	4	320	1
Arlington	2.16	.62	5	259	2
Virginia	1.80	.52	6	102	7
Chiquita	1.52	.44	7	152	5

MISCELLANEOUS BEANS.

Several other varieties of beans were tested for green-manure production, the yields of which are given in Table XVI. These beans were planted on May 16 in rows 44 inches apart and cultivated between the rows until the vines covered the ground.

TABLE XVI.—*Yields of miscellaneous varieties of beans grown on the Yuma Experiment Farm in 1916.*

Variety.	Yields per acre.			Variety.	Yields per acre.		
	Forage (tons).		Seed (pounds).		Forage (tons).		Seed (pounds).
	Green.	Air dry.			Green.	Air dry.	
Chinese velvet	15.9	4.03	.....	Kulti	.....	.....	810
Jack	11.58	3.47	.....	Tepary	5.97	2.18	612
Hyacinth	4.87	1.2	895	Moth	9.7	2.16	.....

Chinese velvet bean.—The Chinese velvet bean (fig. 7) was the heaviest yielding of all summer legumes grown in 1916, a growth of 15.9 tons of green matter, or 4.03 tons of air-dry hay, per acre being

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FIG. 7.—A plat of Chinese velvet beans in the foreground and a plat of hyacinth beans at the left, on the Yuma Experiment Farm in 1916.

produced. This bean, however, failed to reach maturity, and no seed was produced, which factor detracts from its value, since seed would have to be imported from other localities for green-manure plantings.

Hyacinth bean.—The hyacinth bean (*Dolichos lablab*) produced seed freely, the pods maturing in 102 days. This plant also gave a good yield of green matter.

Tepary bean.—Tepary beans in this test produced a good forage yield but a rather light seed yield. For seed production this bean should be planted earlier in the season for a spring crop or later for a fall crop.

Moth bean.—Moth beans produced a very good yield of green matter but failed to set either flowers or seed. It seems that the climate is not suitable for the maturing of this plant.

Kulti bean.—The Kulti beans while producing a fair seed crop made only a small plant growth as compared with other varieties and could scarcely compete as a green-manure crop.

FIG. 8.—A single plant of jack bean grown on the Yuma Experiment Farm in 1916.

Jack bean.—The jack bean produced a very heavy plant growth, and where the stands were good it equaled the Chinese velvet bean. It requires a long season to mature a full crop of seed, however, and unless efforts that are being made to select an earlier maturing plant are successful the variety will probably not be of much importance as a green-manure crop for this locality. Individual plants grow to enormous size, as shown in figure 8.

VETCH.

Three varieties of vetch and one variety of grass pea were included in a green-manure test planted on November 6, 1915. These crops were harvested in the spring of 1916 at a time when the growth was best to be turned under (Table XVII). Very little seed was produced by any of these varieties. The seed of all the varieties was inoculated before planting.

TABLE XVII.—*Yields of varieties of vetch and of grass peas grown on the Yuma Experiment Farm during 1915 and 1916.*

Variety.	Yields per acre (tons).		Variety.	Yields per acre (tons).	
	Green.	Air dry.		Green.	Air dry.
Common vetch	2.8	1.0	Purple vetch	2.33	0.68
Grass pea	2.23	.74	Bitter vetch	2.2	.70

FIELD PEA.

The field pea is one of the very best winter green-manure crops that has thus far been found for this region. There are a large number of varieties of this crop and a marked difference in their behavior. Consequently a rather extensive variety test was conducted at this station during the winter of 1915–16. Row plantings including 48 varieties were made on November 15 on medium-heavy soil. During the following January these plants were under 2 feet of flood water for at least three days, which no doubt retarded growth but did not kill out any variety. Among the 48 varieties are 15 that are more desirable than others both as to forage and seed production. These varieties are listed in Table XVIII, with notations as to their relative production.

TABLE XVIII.—*Yields of the more productive varieties of field peas grown on the Yuma Experiment Farm in 1915–16.*

Variety.	Date of mature seed.	Relative yield.		Variety.	Date of mature seed.	Relative yield.	
		Seed.	Forage.			Seed.	Forage.
Canadian Beauty	Apr. 13	Heavy	Medium	Hubert	Apr. 2	Medium	Heavy.
Brown Abyssinian	Apr. 12	do	do	Vida	Apr. 25	do	Do.
Openshaw	Apr. 10	do	do	White Scimitar	do	do	Do.
Smiley	do	do	do	Multiplier	do	do	Do.
Admiral	Apr. 25	do	do	Bangalia	Apr. 12	Heavy	Light.
Anderson	Mar. 20	Medium.	Heavy	Toreador	Apr. 5	do	Do.
Spokane	Apr. 15	do	do	Golden Vine	do	do	Do.
French Gray	do	do	do				

The combination of the characters of a variety to produce both forage and seed in this climate seems very desirable, as there is a decided need for a good winter green-manure plant of which seed can be produced locally.

Five of the varieties included in the above test were sown broadcast in field plantings and produced yields of hay in the order following: Kaiser, Scotch Blue, Amraoti, Golden Vine, and Bangalia. The three heaviest seed producers in order were Amraoti, Bangalia, and Golden Vine. These tests will be repeated during 1916–17.

IRRIGATION REQUIREMENTS.

Determinations of the amount of water used for the production of crops on the experiment farm were recorded in 1916 as during previous years, with but very little change in results. The local office of the Reclamation Service has assembled the records of water requirements over the Yuma project as a whole and a summary is presented in Table XIX.

TABLE XIX.—*Water requirement for the Yuma Reclamation Project for the year 1916.*

Month.	Area irrigated.	Total water diverted.	Unused water.	Water delivered to farms.		
				Total.	Percentage of total.	Per acre irrigated.
	Acres.	*Acre-feet.*	*Acre-feet.*	*Acre-feet.*		*Acre-feet.*
January	4,301	6,613	4,422	2,191	2.3	0.07
February	7,546	6,548	2,910	3,638	3.9	.12
March	13,610	20,319	12,200	8,119	8.6	.28
April	14,573	21,006	11,851	9,155	9.7	.31
May	15,353	26,660	16,913	9,747	10.3	.33
June	15,642	32,639	19,262	13,107	13.9	.45
July	14,795	29,673	18,280	11,393	12.1	.39
August	17,480	33,750	19,521	14,229	15.1	.48
September	14,672	28,477	17,760	10,717	11.4	.36
October	9,998	21,050	14,582	6,468	6.8	.22
November	6,011	19,230	15,622	3,608	3.8	.12
December	3,589	4,005	1,984	2,021	2.1	.07
Total for year	29,483	249,700	155,307	94,393	100	3.20

Water accounted for as unused is that lost by seepage and evaporation from canals and also the amount of water turned back into the river through wasteways.

It will be noted that the average use of water during 1916 was 3.2 acre-feet per acre. This was a slight increase in water duty over the previous year and an increase of approximately 100 per cent in the efficiency of water utilization during the past five years, as can be seen by reference to Table II. In other words, the water delivered per acre irrigated decreased from 7 acre-feet in 1912 to 3.2 acre-feet in 1916.

ORCHARD FRUITS.

DATES.

The dates being grown on the experiment farm are all seedlings from good varieties, but do not include any true-named varieties from offshoots. Among the oldest plantings, which were 5 years of age this season, 27 per cent flowered, about four-fifths of which were male trees and one-fifth female. Of the entire planting 4 per cent ripened fruit, the time of maturity extending from September 21 to October 10.

During the year 384 Tafilet and 14 Deglet Noor seedlings were transplanted from nursery to orchard positions. Out of a total of 6,680 seedlings now growing on the farm 2,800 are in permanent positions, while others remain in nurseries. Those in the nurseries, a total of 3,880, will be sufficiently developed to transplant to orchard positions during 1918, a few being planted on the experiment farm and the remainder distributed among cooperators.

The transplanting of seedling date palms can best be done during May or early June, after the soil has become thoroughly warm. Ordinarily, seedlings have attained sufficient growth to be trans-

planted when 3 years old from seed. In preparing to transplant seedlings the leaves should be pruned back severely, allowing only one central leaf to remain. Each palm should be dug with a good-sized ball of earth, as the success of starting transplanted palms depends largely on the protection of the roots in this way. When planting in orchard positions the palms should be spaced 5 to 6 feet apart in rows 25 feet apart. The best results have been obtained by setting the plant on the edge of a furrow previously irrigated, taking great care to locate the palm sufficiently high to prevent the earth or irrigation water from coming too close to the crown of the plant. As soon as possible after planting, an irrigation should be given through the furrow, in order to settle the earth firmly about the roots. Weekly irrigations will be required during the first two months following transplanting, after which time the interval between irrigations may be increased. The furrow should be cultivated after each irrigation. To secure a rapid growth of date palms it seems essential that an abundant and uniform supply of moisture be maintained in the soil. A practice that has proved very beneficial in obtaining this condition has been to apply a heavy mulch of hay or straw about each palm. This is accomplished by forming a shallow basin about 6 inches deep and 4 feet broad extending on both sides of the row, in which the mulch material is evenly spread 6 to 8 inches deep, as shown in figure 9. By this practice the moisture has been conserved, the number of irrigations being reduced at least one-half; also the growth of weeds and Bermuda grass is greatly checked.

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FIG. 9.—Seedling date palms, four months after transplanting, mulched with barley straw, on the Yuma Experiment Farm in 1916.

DECIDUOUS FRUITS.

Forty-one varieties were added to the deciduous variety orchard which is under test at this station, among which were 16 varieties of peaches, 4 of plums, 4 of almonds, 1 nectarine, 3 apricots, 1 plumcot, 3 cherries, 2 pears, 2 apples, 1 persimmon, 1 jujube, and 1 pecan.

Notes regarding the growth of these various fruits, such as have been recorded each year, were made during 1916 and with those of previous years are summarized in Table XX.

TABLE XX.—*Growth of deciduous fruit trees on the Yuma Experiment Farm from 1913 to 1916, inclusive.*

Fruit.	Number of varieties.	Number of trees.	Average season's growth.				Average total growth at four years.	
			1913	1914	1915	1916	Extreme height.	Trunk diameter.
			Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Inches.*
Peach	40	83	3.8	6.3	6.54	5.59	12.52	4.44
Plum	19	39	3.3	4.9	5.06	3.93	9.24	3.06
Prune	8	15	3.2	4.2	5.22	4.26	10.73	3.18
Apricot	5	14	3.6	5.3	6.33	5.75	12.23	4.27
Nectarine	2	4	3.7	5.3	6.04	4.87	11.55	4.2
Plumcot	1	2	3.0	6.0	7.1	4.5	10.8	4.09
Cherry	6	10	.....	3.03	4.12	2.45	9.11	2.68
Pear	19	61	2.2	3.2	3.93	3.1	8.86	2.39
Apple	14	30	2.1	4.2	4.09	3.18	8.53	2.43
Quince	4	8	3.2	4.1	4.41	2.81	8.21	2.21
Pecan	5	10	.39	.42	1.78	2.79	6.53	1.53
Walnut	5	5	.35	1.9	4.91	4.6	10.12	3.17
Almond	5	9	3.0	4.4	5.09	3.94	9.54	3.93
Pistache	11	33	2.9	1.95	2.53	2.22	9.71	2.46
Persimmon	11	16	.75	1.3	1.29	1.85	.....	1.24
Olive	5	12	.....	.26	2.68	2.23	6.14	1.84
Jujube	2	3	2.75	4.3	3.43	2.17	10.6	3.43

Among the varieties in this orchard that have matured fruits are a few almonds, apricots, plums, quinces, and peaches. Of 31 varieties of peaches that were planted in 1913, 11 produced yields in 1916, as shown in Table XXI.

TABLE XXI.—*Yield of peach varieties producing fruit at four years of age on the Yuma Experiment Farm in 1916.*

Variety.	Average ripening date.	Number of trees.	Average yield—		
			Per tree, 1916.	Per acre, 115 trees.	
				1916	1915
			Pounds.	*Bushels.*	*Bushels.*
Ceylon	Aug. 1	2	121	278	32
Pallas	July 16	2	97	223	56
Climax	July 30	2	96	219	128
S. P. I. No. 32379	...do....	1	90	207	109
S. P. I. No. 32372	July 5	1	50	115	17
Honey	...do....	1	35	81	47
Mamie Ross	...do....	2	6	14	12
S. P. I. No. 32380	July 31	1	3	7	.....
Elberta	Aug. 1	2	2	5	.....
Triumph	June 19	2	1.5	3.5	.....
Imperial	July 16	1	1	2.3	.....

Although this orchard has not been in bearing long enough to warrant final conclusions regarding any of these fruits, there has been sufficient performance by several of the varieties to establish the worth of a few of the most desirable. In order that farmers who are ready to plant fruit may take advantage of this early in-

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FIG. 10.—A Climax peach tree, 3 years old, bearing a heavy crop on the Yuma Experiment Farm in 1916.

formation, such varieties as may be planted with reasonable assurance of success are listed in the following paragraphs:

Apricots.—Varieties of apricots that have succeeded are the Newcastle, Royal, and Tilton. Of these, the Newcastle is the earliest in season.

Peaches.—The Climax, Ceylon, Pallas, Honey, S. P. I. No. 32379, and S. P. I. No. 32372 varieties of peach have all borne good crops of fruit at an early age. Of these varieties the Climax (fig. 10) and the Red Ceylon are the best shippers. The Honey

and Pallas are early and regular bearers, but seem inclined to be short lived. This objection may possibly be overcome, however, by having these varieties budded on a more vigorous rootstock than has thus far been used. These two varieties, being strictly southern peaches, must at present be obtained from southern nurseries, which may, in part, account for an unadapted stock. The two varieties listed under S. P. I. numbers are varieties distributed by this department and have not as yet been named. Bud wood of any of these varieties may be obtained from the experiment-farm orchard if any local farmers care to propagate their own trees.

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FIG. 11.—A Smyrna quince tree 3 years old, bearing fruit, on the Yuma Experiment Farm in 1916.

Plums.—The worthy and productive plum varieties are the Gonzales, Climax, Shiro, Santa Rosa, and Formosa.

Pears.—The Winter Bartlett, Bartlett, and Winter Nelis varieties of pears have all fruited in this locality.

Quinces.—The Smyrna (fig. 11) and Orange varieties of quince have come into bearing early and are very productive.

Almonds.—Among the almonds that have been found to fruit best as young trees are the Nonpareil and the I. X. L.

Figs.—The fig has been grown in this region for a number of years. The varieties of common figs that are adapted are the Black San Pedro, Brown Turkey, and Mission. By the introduction of the pollinating insect (*Blastophaga prenes*) the Smyrna type of fig may also be grown.

Pomegranates.—The best of the named varieties of pomegranates yet tested on the experiment farm are the Wonderful and Sweet Fruited. The first-mentioned variety is medium acid in flavor, with flesh of a gorgeous red color, being very attractive as a salad fruit. The second is one of the sweetest types, with soft seeds. In addition to a variety test of pomegranates, more than 200 seedlings are being fruited at this station. Among these, several desirable sorts have been found, which are being tested further.

BERRY FRUITS.

Comparatively few of the small fruits can be profitably grown in this climate of hot, dry summers, even when abundant irrigation is

furnished. In the experimental plantings conducted at this station, certain varieties of blackberries, dewberries, and strawberries have grown vigorously and produced good crops of fruit, but all attempts to grow plants of raspberries and raspberry hybrid types have proved unsuccessful.

Blackberries and dewberries.—Blackberries and dewberries require a rich loam soil and an abundance of water. Plantings should be made during February, placing the plants 4 feet apart in the rows. Blackberry rows should be 8 feet apart and dewberry rows 6 feet apart. These distances allow sufficient space for growth and cultivation. Each summer after the fruiting season has passed, all old canes should be removed and the young canes of blackberries should have the tips pinched off when a growth of 3 to 4 feet is reached. As soon as the patch has been well cleaned in the fall a liberal application of manure is very desirable. The Crandall and McDonald[1] blackberries and the Mayes and Gardenia dewberries have proved well adapted to these conditions.

Strawberries.—On account of the hot, dry summers, strawberries are more difficult to grow than blackberries or dewberries. The most desirable soil is a heavy loam, rich in organic matter and capable of retaining moisture. Plantings may be made either in the fall or in midwinter, and the plants do best on beds about 18 inches wide with two rows to a bed and plants 18 inches apart in the row. The strawberries should then be irrigated through the furrow at weekly intervals during the summer and about twice a month during the cooler season of the year. The furrows should always be cultivated after each irrigation and the beds kept free from weeds and grass by hoeing. The varieties that have succeeded in experimental plantings here are the Arizona (everbearing), Gold Dollar, Ozark, and Ettersburg No. 80.

VEGETABLES.

The various phases of truck-crop production have been given some attention in each of the progress reports of this station for the last three years. In addition to what has already been said in regard to varieties and the culture of vegetables under test, a discussion of some additional work during the past year may well be added.

PEAS.

The dates of the first picking of the varieties of peas grown in a varietal test during 1916 are recorded in Table XXII.

[1] The McDonald blackberry is usually self-sterile and therefore should always be planted with another variety that blossoms at the same time, to insure cross-fertilization. Otherwise, it is unfruitful.

TABLE XXII.—*Varieties of peas grown on the Yuma Experiment Farm in 1916.*

Variety.	Date planted, 1915.	Date first picked, 1916.	Variety.	Date planted, 1915.	Date first picked, 1916.
Gradus	Sept. 28	Mar. 17	Pride of Cahuenga	Sept. 28	Mar. 24
Nott's Excelsior	do	do	Yorkshire Hero	do	Mar. 25
Dwarf Telephone	do	do	Premium Gem	do	Do.
American Wonder	do	do	Pride of Cahuenga	Dec. 10	Apr. 3

The Pride of Cahuenga and Dwarf Telephone are good producers of large pods which are uniformly well filled. The Yorkshire Hero and Premium Gem, while yielding a somewhat smaller crop, are of good quality and worthy of recommendation for home gardens.

BEANS.

Most varieties of beans have not been successfully grown in this region, as they seem to be too sensitive to the extreme climatic conditions to produce profitable crops. The selection of varieties is therefore very important. For green beans the Stringless Green Pod variety is one of the few that produces good beans. It is a prolific bearer, the pods being tender and of excellent flavor. For dry beans the Blackeye[1] and tepary are well adapted to this dry climate and will produce good yields. About 100 days are required to mature a crop of these varieties. The Pink bean, while producing good crops during some seasons, is not to be depended on. If beans are planted in early spring a crop is often produced before being damaged by the intense summer heat. Also a late summer crop planted about August 1 will yield well unless early frosts occur. Beans succeed best on light loam soil and may be planted either on the flat or in ridges. Overirrigation should be guarded against, and a thorough cultivation should follow each irrigation.

CHICK-PEAS.

Four selections of the chick-pea (Mexican garbanzo) were planted on May 13 in rows 44 inches apart and cultivated for seed production. The plants matured very early, requiring only 39 days to ripen the crop. The yields, however, were low, the highest being 324 pounds per acre. It is known that this legume will produce much better seed yields if planted during October or November as a winter crop. The plant will endure some frost and set seed early in the spring.

CUCUMBERS.

Cucumbers require a rich soil, medium heavy and retentive of moisture. Plantings that were made late in February and early in March bore fruit large enough to pick on May 10, the main crop

[1] While commonly called a bean in southern California, the Blackeye is elsewhere known as a cowpea.

coming off about June 5. Ridges about 5 feet broad should be prepared and the furrows irrigated before plantings are made. Hills should be planted about 3 feet apart on each side of the ridge. Frequent irrigations will be required, and careful cultivation should follow each irrigation as long as the growth of the vines will permit. The White Spine variety is an early sort and very good for producing cucumbers for pickling, while the Long Green is an excellent variety for market. The White Spine during 1916 yielded 3.4 tons per acre.

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FIG. 12.—A bed of White Bermuda onions producing seed on the Yuma Experiment Farm in 1916.

SWEET CORN.

The well-known varieties of eastern sweet corn have proved so uniformly unsuccessful in this climate that field-corn varieties of the Mexican June type have been generally grown for green corn. However, the introduction of Papago sweet corn by the Arizona State Experiment Station has met the need of a sweet-corn variety that will mature even during the hottest periods of the summer. It may be planted from February to September, the spring plantings producing roasting ears in about 115 days and the summer plantings in 70 days. This variety should be planted in drill rows with plants about 10 to 12 inches apart in the row and given culture similar to that required by field corn, except that more frequent irrigations seem to be desirable to produce the best quality of roasting ears.

ONION-SEED PRODUCTION.

Among the many plants that produce large crops of seed in this climate it has been found that onions may be one of the most profitable. Tests in onion-seed production have been conducted on this farm with the two varieties especially well adapted for bulb production, namely, White Bermuda and Crystal Wax. The bulbs planted in September will mature seed for harvest in May by practically the same cultural methods as are used for the production of market onions. The planting beds were laid off with a 14-inch lister

by plowing a furrow every 3 feet across the field, leaving beds broad enough to carry two rows of onions, one on each edge of the ridge. Bulbs ranging in size from 1½ to 4 inches in diameter were planted 3 inches apart in the row. From such plantings the Crystal Wax variety yielded at the rate of 1,351 pounds of recleaned seed per acre and the White Bermuda at the rate of 1,305 pounds per acre. The quantity of bulbs necessary to plant an acre by this method is about 238 bushels or 13,090 pounds, normally worth in this locality at planting season about 3½ cents a pound. This would demand an outlay of $458 per acre for seed onions, but onion seed at even one-half the normal prices would yield a handsome net return per acre. Such an industry could, of course, be carried on profitably only by extremely careful gardeners, as the success of the crop depends largely on thorough culture. A good soil must be selected for growing onion seed, a well-fertilized, light, sandy loam being the most desirable. The most difficult problem that is likely to be met in establishing an onion-seed industry in this locality is that of holding over the desirable bulbs from harvest time in May or June until planting time in September, as onions do not keep well during the hot summer. A bed of White Bermuda onions producing seed is shown in figure 12.

ORNAMENTAL PLANTS.

Little information can be added to what was given in the report of the work on the Yuma Experiment Farm for 1915 regarding the behavior and value of the varieties of ornamental plants that are now being grown here. Those well established are continuing to develop satisfactorily, while others that are apparently not well adapted are lingering in their growth and are far from promising. During the winter and spring of 1916, 228 ornamental plants were added to the collection already being grown, among which were included 56 new species and varieties and 9 which were already represented. Of the total number of plants, 139 were alive at the close of the year, which shows a loss of 39 per cent.

Approved:
WM. A. TAYLOR,
Chief of Bureau.

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